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Impact of Molasses and Ground Corn Grains as a Source of Energy Supplementation on Composition, Quality, Nutritional Values and *in vitro* Gas Production Parameters of Corn Stover Silage

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ABSTRACT

After harvesting ears, green corn stover was cut to 1.5 to 2.0 cm using a harvester chopper. It was then either left unsupplemented (T1) or supplemented with 3% molasses (T2) or 3% ground yellow corn grains (T3) and stored for 45 days in 0.5 kg capacity plastic bags. Samples were subsequently analyzed for chemical composition, silage quality, and *in vitro* gas production. Supplementing corn stover silage with molasses or ground corn grains significantly enhances dry matter, crude protein, and nitrogen-free extract levels, while decreasing crude fiber and various fiber fractions compared to the control. Organic matter, ether extract, and ash contents remain largely unchanged by these treatments. Supplementation of corn stover silage with molasses and ground corn grain decreases pH and butyric acid concentration, while increasing total volatile fatty acids, lactic, acetic, and propionic acids concentrations, with ammonia-N levels remaining largely unchanged. Cumulative gas production showed a marked increase when molasses and ground corn grains were added to corn stover silage, enhancing degradable fractions and total gas output. Although methane production components declined, gas production was rapid in the first 12 hours, moderate in the next, and slower thereafter. The supplementation notably improved short-chain fatty acid concentration, microbial protein production, dry matter intake, degradability, digestibility, total digestible nutrients, and energy metrics ($P<0.05$). On conclusion, supplementing corn stover silage with molasses or ground corn grains enhances its chemical composition, quality, and nutritional value, resulting in more efficient in vitro gas production.

HIGHLIGHTS

- Effects of adding molasses and ground corn grains on composition and quality of corn stover silage.
- Effects of adding molasses and ground corn grains on *in vitro* gas production parameters.

Keywords: Corn stover silage, Molasses and corn grains, Composition and quality, Nutritional values, *In vitro* gas production

In Egypt, a total of three million feddans were dedicated to corn crop planting (Agriculture Economics and Statistics Institute, 2024).Green corn stalks constitute approximately 55 to 65% of the total corn plant at the time of harvest (Bendary *et al.*, 2001a). The average productivity of green corn stalks is approximately 15 tons per feddan (Bendary *et al.*, 2001b). High-quality silage production from fresh corn stover is crucial for summer animal feeding, with or without additives. This preservation method involves fermenting chopped corn stalks, leaves, and husks in anaerobic conditions, ensuring the nutritional value is maintained for ruminant feed such as cows (Ahmed *et al.*, 2003; El-Garhy, 2007).

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Adding molasses and ground corn grains to corn stover silage improves its nutritional value and fermentation quality. Molasses enhances lactic acid and VFA production while lowering ammonia-N, thus aiding in silage preservation. Ground corn grains raise dry matter and nitrogen-free extract content (El-Garhy, 2007). Lactic acid bacteria ferment molasses carbohydrates to produce lactic acid, which lowers pH and inhibits undesirable microorganisms (Oduguwa *et al.*, 2007). An optimal molasses input of 3% was identified at 35 days of fermentation, resulting in decreased pH and increased lactic acid levels, alongside slight enhancements in crude protein and dry matter content (Bilal, 2009).

Adding molasses and corn grains to corn stover silage improves its nutritional quality and fermentation characteristics. Molasses aids in lactic acid production, lowers pH, and enhances digestibility, while corn grains elevate dry matter and crude protein levels, resulting in superior fermentation (Bautista-Trujillo *et al.*, 2009; Bostami *et al.*, 2008). Additionally, the inclusion of molasses promotes stability and nutrition in the silage, while decreasing ammonia-N levels, indicating improved protein preservation (Wang *et al.*, 2022).

Ground corn grains improve the dry matter and carbohydrate content in silage, enhancing its nutritional value and digestibility for livestock (Bilal, 2009). By selecting energy additives, farmers can further increase the nutritional value and preservation of corn stover silage, leading to better livestock performance and fermentation quality (Gaafar *et al.*, 2023; Li *et al.*, 2024).

Corn stover silage's nutritional quality and fermentation can be enhanced by adding molasses and corn grains, which affect *in vitro* gas production kinetics. Molasses acts as an energy source that promotes lactic acid fermentation, leading to lower pH and better digestibility. Corn grains contribute starch that supports fermentation and may increase gas production. The effectiveness of these additives relies on their types, quantities, and fermentation duration (El-Garhy, 2007). Incorporating energy additives like molasses or bacterial inoculants can boost gas production, fermentation, and nutritional value by encouraging lactic acid bacteria growth and improving fermentation quality (Mejia-Uribe *et al.*, 2013).

This study examines the impact of molasses and ground corn grains on the nutritional values, quality, chemical composition, and *in vitro* gas production parameters of corn stover silage.

MATERIALS AND METHODS

Ethical approval

The following study was declared by the Local Experimental Animals Care and welfare Committee's Ethics Committee and done according to the rules of Kafrelsheikh University, Egypt. (No. 4/2016EC).

Silage making

After harvesting, corn stover was chopped to 1.5 to 2.0 cm. In treatment T1, it was left untreated; T2 incorporated 3% molasses; and T3 contained 3% crushed yellow maize grains. The mixtures were compacted in plastic bags for a 45-day ensiling period. Following ensiling, samples were analyzed for nutritional values, proximate composition, silage quality, and *in vitro* gas production.

Silage quality

To evaluate silage quality, 20 grams of wet silage were combined with 100 milliliters of distilled water and filtered through Whatman No. 40 sheets. The filtrate's pH was measured using a Bechman pH meter. Total volatile fatty acids (TVFAs) were quantified according to Warner (1964), ammonia-N concentration was assessed via AOAC (2005) methods, and lactic acid concentration was calculated through titration with 0.1 sodium hydroxide using the formula: Liquid NaOH x 0.09/sample weight equals lactic acid percentage of DM.

Proximate analysis

The study assessed dry matter content and crop yield by weighing fresh crops and drying them at 60°C. Following AOAC (2005) standards, chemical analysis of ground samples identified components, calculating NDF, ADF, and ADL fiber fractions using Van Soest (1991) methodology. Cellulose = ADF - ADL, while hemicellulose = NDF - ADF.

Nutritional Values

The calculation of total digestible nutrients (TDN) with the formula: TDN % = 40.2625 + 0.1969*CP + 0.4228*NFE + 1.1903*EE - 0.1379*CF (AAFCO, 1997).

Digestible crude protein (DCP) was calculated as DCP % = 0.803*CP – 1 (Knight and Harris, 1966).

Digestible energy (DE) and gross energy (GE) were computed using MAFF (1975) as: GE (Mcal/kg DM) = (0.226*CP + 0.177*CF + 0.407*EE + 0.192*NFE)/4.184 and DE = (GE*(87.9 – (.88*CF)))/100.

In vitro gas production

The assessment of *in vitro* gas production was conducted using the methodology of Menke and Steingass (1988), with a calibrated glass syringe containing 100 mg of air-dry feedas outlined by Onodera and Henderson (1980). Bueno *et al.* (2005) conducted an experiment using three rumen-cannulated lambs fed a mixture of commercial concentrate and rice straw. Rumen contents, composed of 50% liquid and 50% solid, were collected before feeding and placed in insulated flasks at 39 °C for anaerobic transport. After filtering the contents through cheesecloth, they were kept at 39 °C with CO_2 saturation until inoculation, where buffer and inoculant were mixed in a CO_2-saturated water bath in a 2:1 v/v ratio (Nasser *et al.*, 2006). The experiment utilized 15 ml syringes of buffered rumen fluid with feed samples, incubated at 39 °C for 96 hours across three iterations, including two blanks. Syringes were agitated bi-hourly, and gas production was measured at intervals (3, 6, 9, 12, 24, 48, 72, and 96 hours) according to Theodorou *et al.* (1994). Analysis of headspace gas pressure and volume was conducted using linear regression. Pellikaan *et al.* (2011) extracted 10 µl samples of headspace gas over incubation times of 3 to 96 hours for GC analysis to measure methane (CH_4) content, correcting for blank incubation and expressing results per 200 mg of DM. Fermentation kinetics were addressed by Ørskov and McDonald (1979):

$$Y = a + b * (1 - e^{-ct})$$

In gas production, *a, b*, and *c* are the rate constants for the soluble fraction, gas production from the instantly soluble fraction, and the insoluble fraction, respectively. The gas production at time (t) is denoted as *Y*, measured in ml/g organic matter (OM).

Feeds were evaluated by measuring gas production from fermentation, specifically using the Gas Production from Soluble Fraction (GPSF) method and the gas produced after three hours of incubation (GP3). Van Gelder *et al.* (2005) also outline a method to assess gas from the fermentation of insoluble fractions (GPNSF) by analyzing gas produced during the incubation from GP3 to GP24.

$$GPSF = (GP3hr * 0.99) - 3$$

$$GPNSF = 1.02 * (GP\ 24\ hr - GP3\ hr) + 2$$

GPSF measures gas production from the soluble fraction (ml/g DM), GPNSF measures gas production from the non-soluble fraction (ml/200 mg DM), and GP 3 hr indicates net gas production (ml/200 mg DM) over three hours.

Together with measurements of crude protein, ash, and crude fat, energy values were determined based on the gas produced after a 24-hour incubation, using a method from researchers in Hohenheim, Germany, which involves thorough *in vitro* incubation of feedstuffs.

$$ME\ (Mcal/kg\ DM) = (2.2 + 0.136*GP + 0.057*CP)/4.184$$

$$NE\ (Mcal/kg\ DM) = (2.2 + 0.136*GP + 0.057*CP + 0.149*EE) *2.2/ 14.64$$

CP (crude protein), EE (extract), GP (net gas production), ME (metabolizable energy), and NE (net energy) are quantified as percentages or metrics associated with dry matter (DM).

Organic matter digestibility (OMD) is calculated following the method outlined by Getachew *et al.* (1998).

$$OMD\ (\%) = 14.88 + 0.889*GP + 0.45*CP + 0.0651*A$$

In this context, A denotes ash percentage, CP signifies crude protein percentage, GP refers to net gas production over 24 hours (in milliliters per 200 milligrams of dry matter), and OMD indicates organic matter digestibility percentage.

Effective Dry Matter Degradability (EDMD) is calculated from *in vitro* gas production data using the equation by Ørskov and McDonald (1979).

$$EDMD = (a + b) + ((a*b) *c)/(c + k)$$

'a' represents gas production from the soluble fraction, 'b' indicates gas production from the insoluble fraction, 'c' is the gas production rate constant, and 'k' denotes the rumen outflow rate at a maintenance level of 2% per hour.

Getachew *et al.* (2005) present a formula for determining short chain fatty acids (SCFA).

$$SCFA\ (\text{Mm}) = (-\ 0.00425 + 0.0222 * \text{GP}) * 100$$

GP represents the net gas production (ml) of the soluble fraction over 24 hours.

The predicted dry matter intake (DMI) of silage is calculated using a formula in accordance with Blümmel and Ørskove (1993).

$$DMI = 1.66 + 0.49 * a + 0.0297 * \text{b} - 4 * c$$

Gas production is quantified through three parameters: (a) the volume from the soluble fraction (ml), (b) the volume from the insoluble fraction (ml), and (c) the gas production rate (ml/hr).

Czerkawski (1986) determined that the production of microbial protein (MP) amounts to 19.3 grams of microbial nitrogen for every kilogram of organic matter digestibility (OMD).

$$\text{MCP (g/kg DM)} = \text{OMD} * 19.3 * 6.25/100$$

Statistical analysis

The data was evaluated using general linear models (GLM) with IBM SPSS Statistics (2020) and one-way ANOVA. Duncan's tests assessed significant differences in mean values among dietary regimens at P<0.05 (Duncan, 1955).

RESULTS AND DISCUSSIONS

Proximate composition

Table 1 illustrates that the supplementation of corn stover silage with either molasses or ground corn grain significantly modifies its proximate composition. Both molasses and ground corn increase dry matter and non-fibrous carbohydrates while reducing crude fiber compared to the control. Molasses additionally raises crude protein content significantly, showing no significant difference from ground corn. Organic matter, ether extract, and ash levels remain stable and unaffected by these treatments.

Molasses addition can slightly increase the dry matter (DM) and crude protein (CP) contents while breaking down cell wall components (El-Garhy, 2007; Bilal, 2009). Additionally, ground corn grains enhance the DM content and nitrogen-free extract (NFE) concentration of corn stover silage and decrease its ash content (Hartutik *et al.*, 2021; Gaafar *et al.*, 2023).

Fiber fractions

Table 1 indicates that the inclusion of molasses and ground corn grains (T2 and T3) in corn stover silage significantly reduced all fiber fractions (NDF, ADF, ADL, cellulose, and hemicellulose) compared to the unsupplemented control (T1) at P<0.05. The decrease in fiber content, especially in digestible fractions like NDF and ADF, indicates higher energy availability for animals consuming silage (Vieira *et al.*, 2025). The addition of molasses decreases NDF and ADF levels, while ground corn grains also affect overall fiber content (Gao *et al.*, 2019). Supplementing with molasses and corn grains lowers lignin and fiber content in corn stover silage, thereby improving its quality (Kareem and Saeed, 2021; Bilal, 2009).

Silage quality

Results in Table 1, show that adding molasses or ground corn grain to corn stover silage improves silage quality by lowering pH and butyric acid levels, and increasing lactic, acetic, propionic acids, and total volatile fatty acids (TVFAs), with molasses demonstrating a greater impact. However, ammonia-N levels remained unchanged. Molasses, regarded as an accessible carbohydrate, promotes lactic acid fermentation and reduces pH levels when added to silage made from new corn stover at concentrations of 2 and 4% (El-Garhy, 2007; Zhang *et al.*, 2024). This enhancement improves silage quality by providing fermentable energy for beneficial bacteria, resulting in better preservation and fermentation outcomes compared to unsupplemented stover, marked by lower pH and increased lactic acid concentration (Bilal, 2009; Ahmed *et al.*, 2021; Gaafar *et al.*, 2023).

Table 1: Effect of energy additives on proximate composition, fiber fractions and silage quality of corn stover silage

Item	T1	T2	T3	±SE	P-value
Proximate Composition %					
DM	34.47b	36.66a	37.05a	0.45	0.010
OM	90.85	91.27	91.32	0.10	0.101
CP	7.29b	7.51a	7.45ab	0.04	0.046
CF	29.45a	27.59b	27.65b	0.35	0.011
EE	2.38	2.42	2.44	0.02	0.376
NFE	51.73b	53.75a	53.78a	0.43	0.039
Ash	9.15	8.73	8.68	0.10	0.101
Fiber Fractions %					
NDF	69.45a	64.59b	65.06b	0.86	0.018
ADF	39.75a	36.97b	37.24b	0.49	0.020
ADL	5.35a	4.98b	5.01b	0.07	0.015
Cellulose	34.40a	31.99b	32.23b	0.43	0.017
Hemicellulose	29.70a	27.62b	27.82b	0.37	0.022
Silage Quality					
pH value	4.37a	4.18b	4.20b	0.04	0.043
Ammonia -N (% of total-N)	2.98	3.02	3.07	0.02	0.265
TVFA's (% of DM)	2.55b	2.74a	2.68a	0.06	0.011
Lactic acid (% of DM)	4.68b	5.14a	5.01a	0.07	0.013
Acetic acid (% of DM)	2.03b	2.23a	2.17a	0.03	0.025
Propionic acid (% of DM)	0.30b	0.35a	0.34a	0.01	0.042
Butyric acid (% of DM)	0.17a	0.12b	0.13b	0.002	0.034

[a, b:] Means in the same row with different superscripts differ significantly at P<0.05.

Accumulative gas production

Adding molasses and ground corn grains to incubated corn stover silage significantly boosts cumulative gas production over 96 hours compared to the control (Fig. 1). While T2 and T3 enhancements show notable improvements, gas production slightly decreases with molasses instead of corn grains. The production patterns indicate a rapid rise in the first 12 hours, moderate increases in the next 12, and a slower rise from 24 to 96 hours, linked to the carbohydrates in the additives. The fermentation of carbohydrates by microorganisms results initially in a rapid gas production spike, which stabilizes as sugars are consumed (Timmermans *et al.*, 2022). Corn grains and molasses notably affect the gas output of corn stover silage by altering fermentation rates (Nogoy *et al.*, 2019). The addition of molasses boosts gas production due to its available carbohydrates and fermentation qualities (Zhang *et al.*, 2024). Corn grains provide starch, which rumen microorganisms convert into gas and volatile fatty acids (VFAs), enhancing total gas output, particularly in late fermentation (Campos *et al.*, 2020; Daoud *et al.*, 2024). Molasses also enhances microbial growth, leading to more VFAs and improved gas production by increasing water-soluble carbohydrates and crude protein in silage (Xu *et al.*, 2013; Xia *et al.*, 2018).

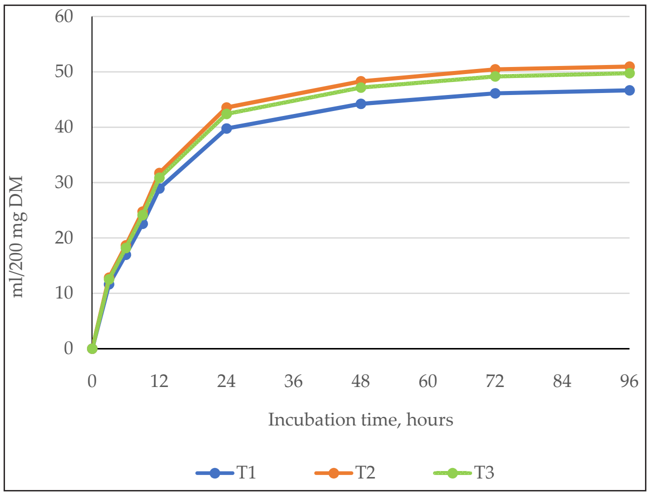

Fig. 1: Effect of energy additives on accumulative gas production of corn stover silage

Kinetics parameters

Energy supplements like molasses and ground maize grains improve the gas production kinetics of maize stover silage significantly (Table 2). Treatments T2 and T3 demonstrate higher gas production rates and degradable fractions than the control (T1), with statistical significance at P<0.05. The inclusion of these energy sources leads to faster and more complete fermentation of corn stover silage. Together, these additives alter fermentation characteristics and gas production curves. The addition of molasses and maize grains to maize stover silage significantly influences *in vitro* gas production kinetics (Xia *et al.*, 2018). Molasses enhances fermentation by providing easily accessible sugars, leading to quicker gas production and a reduced lag phase, while its starch content boosts total gas production potential (DePeters *et al.*, 2003; Pongsub *et al.*, 2024). Corn grains also accelerate gas formation due to their high starch content, affecting volatile fatty acid generation and consequently impacting animal performance (Yulistiani and Nurhayati, 2018; da Silva Zornitta *et al.*, 2021).

Gas fractions

Table 2 shown, incorporating molasses and ground corn into corn stover silage (T2 and T3) led to significantly increased gas production from both soluble and insoluble fermentation fractions, in contrast to the control (T1), at a significance level of $P<0.05$. The energy supplements facilitate the breakdown of various feed components (Li *et al.*, 2024). Molasses and corn grains notably impact *in vitro* gas production from corn stover silage, affecting both soluble and insoluble fractions (Ayandiran *et al.*, 2024). Corn grain generates gas from its degradable insoluble component, and molasses addition boosts gas production from the soluble fraction (Nayel *et al.*, 2019). Furthermore, molasses enhances total gas production and the rate constant of the insoluble fraction in gas generation (Ayandiran *et al.*, 2024).

Table 2: Effect of energy additives on kinetics parameters and fractions of gas production of corn stover silage

Item	T1	T2	T3	±SE	P-value
Kinetics parameters					
a (ml/200 mg DM)	5.14b	5.53a	5.48a	0.06	0.012
b (ml/200 mg DM)	36.79b	39.56a	39.23a	0.46	0.010
c (ml/hour)	0.054b	0.058a	0.057a	0.001	0.021
Gas fractions					
GPSF (ml/200 mg DM)	8.51b	9.69a	9.39a	0.19	0.017
GPNSF (ml/200 mg DM)	30.71b	32.72a	32.48a	0.34	0.026

a, b: Means in the same row with different superscripts differ significantly at $P<0.05$.

Methane production (CH_4)

Fig. 2 illustrated that the synthesis of methane from maize stover silage is affected by energy source additions and incubation duration. Supplementation with molasses and ground corn grains leads to significantly lower methane production compared to unsupplemented silage, with molasses causing a slight decrease relative to maize grains. Methane production initially spikes in the first 12 hours, continues to rise steadily up to 24 hours, and seeps growth until 96 hours.

Increasing fiber in animal feed typically elevates methane production in ruminants, especially cows, through fiber fermentation by rumen microbes (Sattarova *et al.*, 2025). This dynamic is influenced by digestibility, diet composition, and animal type (Nurdianti *et al.*, 2024). The addition of molasses and corn grains to silage alters methane emissions, with molasses potentially reducing methane output and corn grains increasing it due to starch content (Kara, 2015; Xia *et al.*, 2018). Furthermore, the type of grain used can impact emissions, as cows fed a corn-based diet tend to produce less methane (Beauchemin and McGinn, 2005).

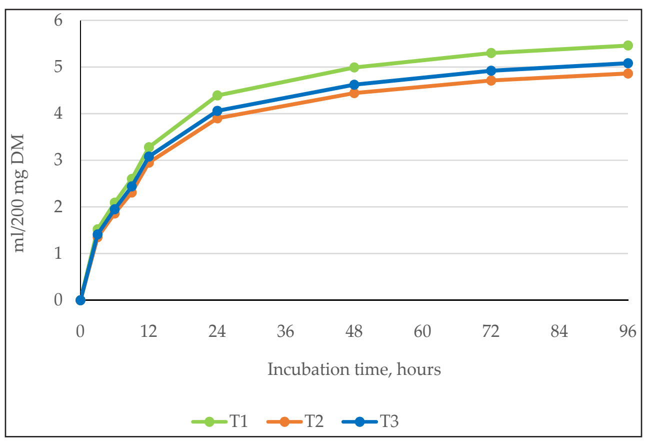

Fig. 2: Effect of energy additives on *in vitro* methane production of corn stover silage

Short chin fatty acids (SCFA)

Fig. 3 indicated that adding molasses and ground corn grains to corn stover silage significantly increased short-chain fatty acid concentrations ($P<0.05$) compared to the unsupplemented treatment. Improved fermentation processes in silage, particularly with the addition of molasses and crushed maize grains, increase the production of short-chain fatty acids (SCFAs) like acetate, propionate, and butyrate, which are essential energy sources for ruminants (Liu *et al.*, 2022; Shi *et al.*, 2025). Molasses significantly boosts gas production and digestibility in the fermentation of corn stover silage, while also affecting SCFA ratios (Direkvandi *et al.*, 2020). Corn grains influence fermentation dynamics, with higher starch content in maize grains potentially enhancing propionate production and altering the acetate to propionate ratio (Khan *et al.*, 2012; Xu *et al.*, 2013; Palmonari *et al.*, 2023).

Microbial protein production

Fig. 3 illustrated that gas production from corn stover silage with energy additions was used to evaluate microbial protein synthesis (MCP) in the rumen. The addition of molasses and ground corn grains significantly enhanced MCP compared to unsupplemented silage, indicating better silage utilization by rumen bacteria with extra energy sources. Adding molasses and corn grains to corn stover silage enhances microbial gas and protein production *in vitro* (Sariçiçek and Kiliç, 2009). Molasses provides an accessible energy source that promotes microbial growth and protein synthesis in the rumen (Xu *et al.*, 2013; Windsor and Hill, 2022). Corn grains, rich in starch, contribute to fermentation and gas production, although their impact on microbial protein synthesis depends on starch breakdown by rumen microbes and the utilization of other nutrients (DePeters *et al.*, 2003; Liu *et al.*, 2020).

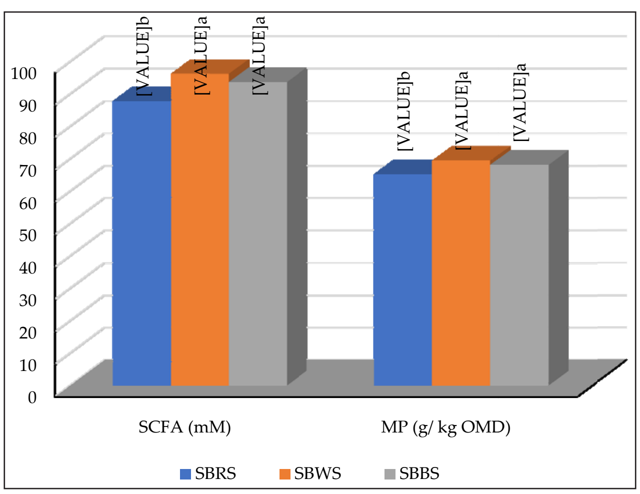

Fig. 3: Effect of energy additives on short chin fatty acids (SCFA) and microbial protein production (MCP) of corn stover silage

Predicting dry matter intake

Table 3 revealed that adding molasses and ground corn grains to corn stover silage significantly enhances dry matter intake (DMI) compared to the unsupplemented control. This is evident in measurements taken in kg/day or kg/kg metabolic live body weight ($P<0.05$). *In vitro* gas production techniques can also predict DMI.Higher *in vitro* gas production correlates with increased dry matter intake (DMI), indicating its potential as a silage quality marker (Ayandiran *et al.*, 2024). Adding molasses and maize grains to corn stover silage enhances DMI and gas production by improving fermentation and digestibility (Kuttu *et al.*, 2025). Molasses acts as a fermentable carbohydrate source, boosting gas production and nutrient availability for microbial fermentation, which further increases DMI (Abreu *et al.*, 2022; Ayandiran *et al.*, 2024). Corn grains also improve fermentation and digestibility, potentially enhancing gas production and DMI (Dong *et al.*, 2020; Kareem and Saeed, 2021).

Effective dry matter degradability and organic matter digestibility

Data in Table 3, showed that supplementing corn stover silage with molasses and ground corn enhances effective dry matter degradability (EDMD) and organic matter digestibility (OMD) compared to unsupplemented silage, thereby improving its nutritional value. Both OMD and dry matter digestibility can be assessed using *in vitro* gas production methods. Molasses improves energy digestibility in silage by enhancing rumen microbial activity, which leads to better effective dry matter digestibility (EDMD) and organic matter digestibility (OMD) (Xu *et al.*, 2013; Ayandiran *et al.*, 2024). Processed corn grains also provide accessible carbohydrates, further boosting OMD by breaking down complex carbohydrates, enhances nutrient digestibility, serving as a valuable starch source that is easily digested in the rumen while fostering microbial activity that positively impacts EDMD (Lee *et al.*, 2002).

Nutritional values

Table 3 indicated that, the addition of molasses and ground corn grains to corn stover silage significantly increased total digestible nutrients (TDN) compared to the unsupplemented control. Both supplements elevated crude protein (CP) levels, but only molasses significantly increased digestible crude protein (DCP), while the increase from corn grain was negligible.

Corn stover silage's nutritional value can be enhanced by adding molasses and corn grains, which improve total digestible nutrients (TDN) and digestible crude protein (DCP) (Bostami *et al.*, 2008). Molasses boosts fermentation, palatability, and energy content, leading to a higher TDN value (Zhang *et al.*, 2024). Ground corn also contributes by increasing TDN and protein content due to its digestible energy (El-Garhy, 2007; Bilal, 2009).

Table 3: Effect of energy additives on predicting dry matter intake, degradability and digestibility and nutritional values of corn stover silage

Item	T1	T2	T3	±SE	P-value
Predicting DM intake					
DMI (kg/day)	5.05b	5.31a	5.28a	0.04	0.012
DMI (g/kg LBW$^{0.75}$)	48.14b	50.57a	50.30a	0.41	0.014
Degradability and digestibility					
EDMD %	46.91b	51.27a	50.68a	0.73	0.022
OMD %	54.11b	57.54a	56.49a	0.53	0.018
Nutritive values					
TDN %	62.34b	63.54a	63.56a	0.23	0.015
DCP %	4.85b	5.03a	4.98ab	0.03	0.046

a, b: Means in the same row with different superscripts differ significantly at P<0.05.

Energy values

Fig. 4 indicated that the addition of molasses and ground corn grains to corn stover silage significantly enhances its energy value, as indicated by increased gross energy (GE), digestible energy (DE), metabolizable energy (ME), and net energy (NE) compared to unsupplemented silage. These supplements also improve fermentation and digestibility, positively affecting *in vitro* metabolizable and net energy.

The incorporation of molasses into corn stover silage increases its energy content by providing accessible carbohydrates that enhance the growth of lactic acid bacteria (LAB) and improve fermentation, leading to greater metabolizable energy (ME) (Bostami *et al.*, 2008; Li *et al.*, 2022; Gaafar *et al.*, 2023). Additionally, adding ground corn raises the total energy density due to its higher starch and digestible carbohydrates, thereby increasing the nutritional value of the silage for ruminants. This also elevates levels of nitrogen-free extract (NFE) and dry matter (DM) (El-Garhy, 2007; Karnatam *et al.*, 2023; Daoud *et al.*, 2024).

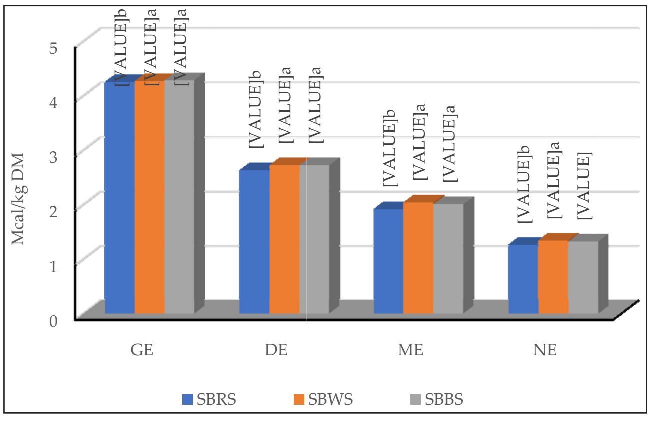

Fig. 4: Effect of energy additives on energy contents of corn stover silage

CONCLUSION

Supplementing corn stover silage with molasses or ground corn grains enhances its chemical composition, nutritional value, and fermentation characteristics, leading to more efficient *in vitro* gas production. These additives can improve the quality and utilization of corn stover silage for ruminant feed.

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